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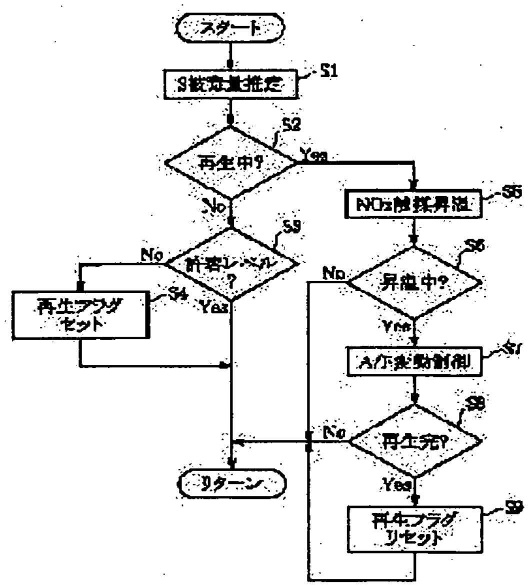
(54) EXHAUST EMISSION CONTROL DEVICE FOR INTERNAL COMBUSTION ENGINE

(57)Abstract:
PROBLEM TO BE SOLVED: To restrict generation of off-flavor due to the sulfur (S) compound included in exhaust gas by fluctuating the exhaust air-fuel ratio of an internal combustion engine around the rich air-fuel ratio as a reference, when sulfur poisoning of the NOx catalyst is detected by a S-poisoning detecting means.
SOLUTION: When storage quantity of NOx of the NOx catalyst, namely, the quantity of S-poisoning is detected (S1), a discrimination as to whether or not the NOx catalyst is being regenerated is done (S2), and if it is 'YES', a fuel injector performs two-stage injection of the fuel so as to raise the temperature of the exhaust gas, namely, the temperature of the NOx catalyst (S5). Thereafter, a discrimination whether or not temperature rise of the NOx catalyst is concluded or not, namely, temperature of the NOx catalyst achieves the SOx activating temperature is done, and if it is 'YES', fluctuation control of the exhaust air-fuel ratio is carried out (S7). The fluctuation control is performed by alternately switching the exhaust air-fuel ratio between the theoretical air- fuel ratio as a lean side of the reference air-fuel ratio and the predetermined rich air-fuel ratio as a richer air-fuel ratio. At the time of switching the air-fuel ratio, detecting signal of an O2 sensor is used.



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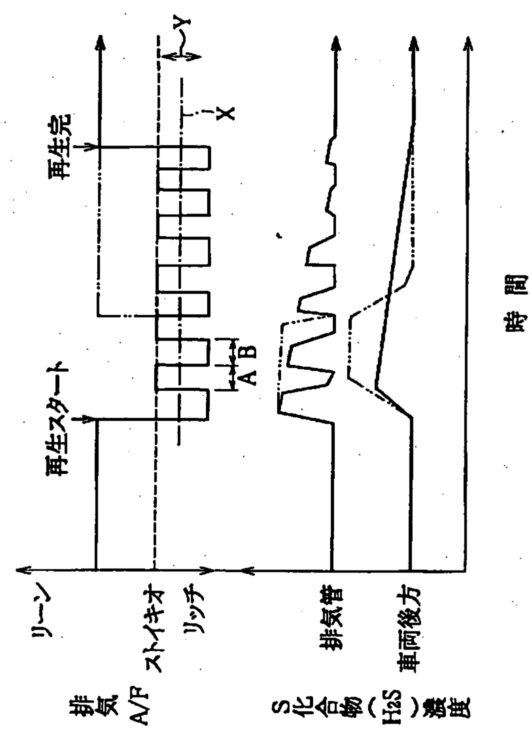
(54)【発明の名称】内燃機関の排気浄化装置

(57)【要約】
【課題】　燃費の向上を図り且つ安価にして、排ガスの異臭を効果的に抑制することができる内燃機関の排気浄化装置を提供する。
【解決手段】　内燃機関の排気浄化装置は、ＮＯｘ触媒１２のＳ被毒量が許容レベルを超えると、リッチ領域内にて排気空燃比を基準のリッチ空燃比を中心として上下に変動させ、ＮＯｘ触媒１２から徐々にＳＯｘを脱離させる。



【特許請求の範囲】

【請求項１】　内燃機関の排気通路に設けられ、排気空燃比がリーン空燃比であるときには排ガス中の窒素酸化物を吸蔵する一方、排気空燃比が理論空燃比以下のときには吸蔵した窒素酸化物を放出し還元するＮＯｘ触媒と、

前記排ガス中のイオウ成分による前記ＮＯｘ触媒のＳ被毒を検知するＳ被毒検知手段と、

前記Ｓ被毒検知手段にて前記ＮＯｘ触媒のＳ被毒が検知されたとき、前記排気空燃比を基準のリッチ空燃比を中心として変動させ、前記ＮＯｘ触媒に吸蔵されているイオウ成分を脱離させる空燃比変動手段とを具備したことを特徴とする内燃機関の排気浄化装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、特に排ガスの無臭化に好適した内燃機関の排気浄化装置に関する。

【０００２】

【関連する背景技術】近年、燃費の向上を目的として車両には希薄（リーン）燃焼型の内燃機関が多く採用されつつある。この種の内燃機関にあっては排気ガス中に多量の窒素酸化物（ＮＯｘ）が含まれるため、その排気通路にいわゆるＮＯｘ触媒を配置している。このＮＯｘ触媒は、内燃機関がリーン空燃比にて運転中にあるときにはその排ガス中のＮＯｘを吸蔵する一方、内燃機関が排気空燃比を理論空燃比以下のリッチ空燃比で運転されるときにはその吸蔵したＮＯｘを放出し還元する機能を有している。

【０００３】ところで、この種のＮＯｘ触媒は、排ガス中のＮＯｘのみならずイオウ成分をも吸蔵してしまい、ＮＯｘの浄化能力の低下を招く。つまり、ＮＯｘ触媒はイオウ成分により被毒される性質を有する。このようなＳ被毒を解消するため、例えば特開平6-66129号公報にはＮＯｘ触媒のＳ被毒が許容レベルを超えると、ＮＯｘ触媒を所定の温度以上に昇温し、且つ、その周囲を還元雰囲気、つまり、排気空燃比をリッチ空燃比にすることでＮＯｘ触媒からイオウ成分を急激に放出還元し、その再生を図る技術が開示されている。

【０００４】しかしながら、上述した特開平6-66129号公報の排気浄化装置にあってはそのＮＯｘ触媒から脱離したイオウ成分が排ガス中の炭化水素（ＨＣ）と反応し、イオウ（Ｓ）化合物（硫化水素：H_2S）が一時的に多量に生成する。このようなＳ化合物、つまり、硫化水素が大気中に多量に放出されると、異臭の原因となり、好ましいものではない。

【０００５】このような事情から特開平8-294618号には大気中への硫化水素の放出を抑制するため、ＮＯｘ触媒の下流に、硫化水素のトラップとその酸化機能を有した触媒コンバータを配置し、一方、排気空燃比を理論空燃比を中心にリーン空燃比とリッチ空燃比との間にて変動、つまり、パータベーションさせる技術が開示されている。

【０００６】

【発明が解決しようとする課題】しかしながら、特開平8-294618号の排気浄化装置の場合、上述の空燃比のパータベーションは、触媒コンバータにてトラップした硫化水素を酸化させるために、つまり、触媒コンバータに酸素を供給する上で必要不可欠であるものの、このような空燃比パータベーションは排気空燃比がリーン空燃比にあるときにＮＯｘ触媒へのイオウ成分の更なる吸蔵を招き、このことは、ＮＯｘ触媒の再生に要する時間を長くしてしまうことになる。

【０００７】また、ＮＯｘ触媒の再生時間が長くなると、空燃比パータベーション中にて排気空燃比がリッチ空燃比となる期間の増大を招き、燃費を悪化させる。更に、上述の触媒コンバータは特別なものであるから、排気浄化装置がコスト高ともなってしまう。本発明は上述の事情に基づいてなされたもので、その目的とするところは、排ガス中のＳ化合物を原因する異臭を抑制し、なお且つ、燃費の悪化やコスト高を招くことのない内燃機関の排気浄化装置を提供することにある。

【０００８】

【課題を解決するための手段】上述の目的は本発明における内燃機関の排気浄化装置によって達成され、この排気浄化装置は、排ガス中のイオウ成分によるＮＯｘ触媒のＳ被毒を検知するＳ被毒検知手段と、このＳ被毒検知手段にてＮＯｘ触媒のＳ被毒が検知されたとき、内燃機関の排気空燃比を基準のリッチ空燃比を中心として変動させる空燃比変動手段とを備えている。

【０００９】上述の排気浄化装置によれば、ＮＯｘ触媒からのイオウ成分の脱離時、排気空燃比が基準のリッチ空燃比を中心として変動されると、つまり、排気空燃比が基準のリッチ空燃比よりもリーン側の空燃比と基準のリッチ空燃比よりもリッチ側のモアリッチ空燃比との間にて変動されると、ＮＯｘ触媒からはそのイオウ成分が徐々に脱離され、排ガス中にＳ化合物が一時的且つ多量に生成されることはない。

【００１０】排気空燃比の変動領域は理論空燃比以下に設定されるのが好ましく、また、被毒検知手段は、ＮＯｘ触媒のＳ被毒のレベルを検出若しくは推定するものであるのが好ましい。そして、Ｓ被毒検知手段にてＮＯｘ触媒のＳ被毒レベルが検知される場合にあっては、そのＳ被毒レベルが高ければ高い程、空燃比変動手段の基準となるリッチ空燃比を大きな値に設定するか、または、排気空燃比の変動制御の開始から所定の期間に亘り、１サイクル中における前記リーン側の空燃比の時間に対して前記モアリッチ空燃比の時間を短くするか、更には前記リーン側の空燃比への移行頻度に対し、前記モアリッチ空燃比への移行頻度を小さくするのが好ましい。

【００１１】

【発明の実施の形態】図１に概略的に示す内燃機関は、例えば筒内噴射型の直列４気筒ガソリンエンジンである。この種の内燃機関は燃焼室に燃料を直接に噴射可能なフューエルインジェクタ２を備え、その運転状況に応じた種々の燃料噴射モード及び排気空燃比にて燃料の噴射が可能である。具体的には、燃料噴射モードには主として吸気行程にて燃料を噴射し、均一燃焼を行う吸気行程噴射モードと、圧縮行程に燃料を噴射し、層状燃焼を行う圧縮行程噴射モードとがあり、特に圧縮行程噴射モードにあっては吸気行程噴射モードでの空燃比（空燃比１２～２３程度）に対し、超リーン空燃比（空燃比２５以上）での燃焼が可能である。

【００１２】内燃機関の排気マニホールド４からは排気管６が延び、この排気管６にはその上流端に小形の三元触媒８が介挿されている。また、排気管６の下流側には触媒コンバータ１０が介挿されている。触媒コンバータ１０は、吸蔵型のＮＯｘ触媒１２と三元触媒１４との組み合わせたもので、ＮＯｘ触媒１２は三元触媒１４の上流側に位置付けられている。ＮＯｘ触媒は酸化雰囲気（排気空燃比がリーン空燃比）であるときＮＯｘを吸蔵する一方、還元雰囲気（排気空燃比がリッチ空燃比）にあるとき、その吸蔵したＮＯｘを窒素（N_2）等に還元する機能を有する。より具体的には、ＮＯｘ触媒１２は白金（Ｐｔ）、ロジウム（Ｒｈ）等の触媒と、バリウム（Ｂａ）等のアルカリ金属やアルカリ土類金属からなる吸蔵材を有している。前述したようにＮＯｘ触媒１２は排ガス中のＮＯｘのみならず、イオウ成分、即ち、ＳＯｘもまた吸蔵する性質を有しており、ＮＯｘ触媒１２の吸蔵材内でのＳＯｘの安定度は高い。それ故、ＮＯｘ触媒１２からＳＯｘを放出還元するにはＮＯｘ触媒１２を所定のＳＯｘ活性化温度（例えば６５０℃）以上に昇温し、なお且つ、その周囲を還元雰囲気にする必要がある。

【００１３】それ故、触媒コンバータ１０には、ＮＯｘ触媒１２に流入する排ガスの温度を検出する温度センサ１６や、必要に応じて排ガス中のＮＯｘ濃度を検出する濃度センサ１８がＮＯｘ触媒１２と三元触媒１４との間に設けられており、これらセンサ１６，１８は電子コントロールユニット（ＥＣＵ）２０に接続されている。また、ＥＣＵ２０には、前述のフューエルインジェクタ２に加え、排ガス中の酸素濃度を検出するO_2センサ２２、点火プラグ２４、スロットル開度センサ２６、そして、クランク角センサ２８もまた電気的に接続されている。

【００１４】ＥＣＵ２０は、マイクロプロセッサを含むワンボード型のマイクロコンピュータからなり、上述のセンサからの検出信号に基づき、前述した燃料噴射モードの切換え制御や、フューエルインジェクタ２、点火コイル２４等の駆動制御する一方、触媒コンバータ１０のＳＯｘ再生制御を実施する。図２にはそのＳＯｘ再生制御の手順が示されており、この再生制御に関し、図２を参照しながら以下に説明する。

【００１５】先ず、ＥＣＵ２０は、ＮＯｘ触媒１２のＳＯｘ吸蔵量、つまり、Ｓ被毒量を推定する（ステップＳ１）。具体的には、Ｓ被毒量Ｑｓは、ＥＣＵ２０が実行する燃料噴射制御ルーチンの実行周期毎に次式を実行することで算出される。Ｑｓ(n)＝Ｑｓ(n-1)＋ΔＱｆ・Ｋ－Ｒｓここで、Ｑｓ(n)は今回算出値、Ｑｓ(n-1)は前回算出値を示す。そして、ΔＱｆ，Ｒｓは実行周期当たりの噴射燃料の積算値、ＳＯｘの放出量、Ｋは補正係数である。

【００１６】補正係数Ｋは、排気空燃比（Ａ／Ｆ）に応じた補正係数K1、燃料中のイオウ成分の含有量に応じた補正係数K2、そして、ＮＯｘ触媒１２の触媒温度に応じた補正係数K3の積、即ち、K1・K2・K2で表される。触媒温度は、前述した温度センサ１６からの検出信号に基づき求められるが、温度センサ１６からの検出信号はＮＯｘ触媒１２の温度を直接に示すものではない。それ故、ＥＣＵ２０は温度センサ１６の検出信号を内燃機関の目標平均有効圧と機関回転速度とから定められたマップに基づき補正することで、ＮＯｘ触媒１２の温度を推定するようにしている。なお、目標平均有効圧及び機関回転数は、スロットル開度センサ及びクランク角センサからの検出信号に基づき求めることができる。

【００１７】また、ＳＯｘの放出量Ｒｓは次式から算出される。

Ｒｓ＝α・Ｒ１・Ｒ２・ｄＴ

ここで、αは単位時間当たりのＳＯｘの放出率（設定値）、ｄＴは燃料噴射制御ルーチンの実行周期を示し、そして、Ｒ１，Ｒ２は触媒温度に応じたＳＯｘの放出能力係数、及び排気空燃比に応じたＳＯｘの放出能力係数を示す。

【００１８】ステップＳ１にて、ＮＯｘ触媒１２のＳ被毒量が推定、つまり、検知されると、ＥＣＵ２０はＮＯｘ触媒１２の再生中（Ｓパージ中）であるか否か、即ち、後述する再生フラグがセットされているか否かを判別する（ステップＳ２）。ここでは未だ、再生フラグはセットされていないので、その判別結果は偽（No）となり、ＥＣＵ２０はＮＯｘ触媒１２のＳ被毒量が許容レベル以下であるか否かを判別し（ステップＳ３）する。ここでの判別結果が真（Yes）の場合、ＥＣＵ２０はステップＳ１，Ｓ２を繰り返して実施する。ここで、Ｓ被毒量の許容レベルは、ＮＯｘ触媒２１の容量から求められる設定値である。

【００１９】一方、ステップＳ３の判別結果が偽になると、ＥＣＵ２０は再生フラグをセットする（ステップＳ４）。この後、ステップＳ２の判別結果は真となり、ＥＣＵ２０はＮＯｘ触媒１２の昇温を実施する（ステップＳ５）。このステップＳ５にて、ＥＣＵ２０はフューエルインジェクタ２に燃料の２段噴射を行わせ、排ガスの

温度を上昇させる。より詳しくは、フューエルインジェクタ２は、圧縮行程又は吸気行程中での燃料の主噴射に加えて、膨張行程にて燃料の副噴射を実行し、この副噴射の燃料が排気管６内にて燃焼することで、排ガスの温度、即ち、ＮＯｘ触媒１２の温度を昇温させる。ここで、燃料の副噴射量は、ＮＯｘ触媒１２の現在の触媒温度に応じて調整され、また、上述の２段噴射が実行される場合にあっても、その全体の排気空燃比がその運転状況に応じて制御されることは言うまでもない。なお、内燃機関が高速域にあって、ＮＯｘ触媒１２の温度が前述したＳＯｘ活性化温度以上に既に達しているような状況にあっては、燃料の副噴射量は零となり、この場合、燃料の２段噴射は実質的に実行されないことになる。

【００２０】この後、ステップＳ６に至ると、ＮＯｘ触媒１２の昇温が完了したか否か、つまり、ＮＯｘ触媒１２の温度がＳＯｘ活性化温度以上に達した否かが判別される。ここでの判別が偽の場合、ステップＳ５が繰り返して実行される。ステップＳ６の判別結果が真になると、ＥＣＵ２０は排気空燃比（Ａ／Ｆ）の変動制御（ステップＳ７）を実行し、その詳細は以下の通りである。

【００２１】ステップＳ７では、排気空燃比がリッチ側の基準空燃比Ｘ（例えば１４．３５）を中心とし、上下に所定の期間変動される。具体的には、排気空燃比は基準空燃比Ｘよりもリーン側の空燃比としての理論空燃比（１４．７）とモアリッチ空燃比としての所定のリッチ空燃比（例えば１４．０）との間にて所定時間（例えば５秒）毎に交互に切換えられる。なお、排気空燃比の切換えには、前述したO_2センサ２２からの検出信号が使用されることは言うまでもなく、そして、この場合、排気空燃比はO_2センサの検出信号から得られる平均値である。

【００２２】上述したようにして排気空燃比の変動制御（Ｓパージ）が実行されると、図３に示されるように排気空燃比は理論空燃比（ストイキオ）よりもリッチ側の領域内にて、基準のリッチ空燃比Ｘを中心とし、その上下に変動される。それ故、ＮＯｘ触媒１２に吸蔵されたＳＯｘはその排気空燃比がよりリッチ側に変動されたときにより多量に放出還元されることから、排気管６内にてＳ化合物の濃度は周期的に増減され、その時間当たりの濃度平均を減少させることができる。また、図３から明らかなようにＳ化合物の周期的な放出に関して、その放出時におけるＳ化合物の濃度レベルは時間の経過と共に徐々に減少していき、これはＮＯｘ触媒１２内でのＳＯｘの吸蔵量が徐々に減少していくことに因るものである。

【００２３】従って、上述の変動制御、つまり、ＮＯｘ触媒１２の再生制御が実行されても、排気管６内にＳ化合物が一時的且つ多量に放出されることはない。このことは、排気管６内にてＳ化合物とH_2等の還元剤との化学反応により得られる硫化水素（H_2S）が一時的且つ多量に生成されないことを意味し、この結果、硫化水素に起因する異臭を効果的に抑制することができる。

【００２４】図３中には、車両後方域でのＳ化合物の濃度変化もまた示されており、また、図３中の２点鎖線は排気空燃比がよりリッチ側の空燃比に維持され続けた場合での排気管内及び車両後方域でのＳ化合物の濃度変化をそれぞれ示している。Ｓ化合物の濃度変化に関し、図３中の実線と２点鎖線を比較すれば明らかなように、本実施例の場合にはその変動制御の開始直後に、車両後方に多量の硫化水素を排出することはなく、自車や後続車内の乗員が異臭による違和感を受けることはない。

【００２５】上述したＮＯｘ触媒１２の再生中、排気空燃比が理論空燃比よりも大のリーン空燃比に切換えられることはないので、ＮＯｘ触媒１２の再生を迅速に行え、燃費の向上が図られる。しかも、本実施例の場合には、硫化水素をトラップするための特別な触媒を必要とせず、安価な排気浄化装置を提供することができる。ステップＳ７の実行後、ＥＣＵ２０は上述のＮＯｘ触媒１２の再生が完了したか否かを判別し（ステップＳ８）、ここでの判別結果が真となるまで、ステップＳ７を繰り返して実行する。一方、ステップＳ８の判別結果が真になると、ＥＣＵ２０は再生フラグをリセットし（ステップＳ９）、この後、ステップＳ３の判別が繰り返して実行される。ここで、ステップＳ８での判別は、排気空燃比の変動制御（ステップＳ７）が開始されてからの経過時間、または、ステップＳ１にて推定したＳ吸蔵量に基づいて実施可能である。

【００２６】ＥＣＵ２０はその排気空燃比を基準のリッチ側空燃比よりもリーン側の空燃比（理論空燃比）とリッチ側の空燃比との間にて変動させるにあたり、フィードバック制御またはオープンループ制御を利用することができる。なお、本実施形態では、基準空燃比Ｘに対して理論空燃比とモアリッチ空燃比との間で変動させているが、基準空燃比Ｘに対するリーン側の空燃比は、理論空燃比よりも若干リッチ側の空燃比に設定してもよい。

【００２７】また、図３におけるＮＯｘ触媒１２の再生ルーチンは車両の走行距離等を考慮し、所定の期間毎に実行されるものであってもよい。この場合、排気空燃比の変動制御（ステップＳ７）を実行するにあたっては、その空燃比の変動幅を一定であるとき、ＮＯｘ触媒１２のＳ被毒量に基づき、その基準のリッチ空燃比Ｘのレベルを図３中矢印Ｙで示すように上下に可変するようにしてもよい。具体的には、Ｓ被毒量が多ければ多いほど、基準のリッチ空燃比Ｘはより理論空燃比側に変位される。このようにして基準のリッチ空燃比Ｘが変位されると、リッチ側への排気空燃比の振れが抑制される結果、排気管６内に一時的且つ多量にＳ化合物が生成されてしまうのを効果的に防止ができる。なお、基準のリッチ空燃比よりリーン側の空燃比は理論空燃比よりもリーン側となることも許容される。

【００２８】また、同様な趣旨に基づき、基準のリッチ空燃比Ｘが一定である場合には、空燃比の１変動サイクル中、図３に示すように排気空燃比が基準のリッチ空燃比Ｘに対してリーン側となる空燃比に維持される時間Ａと、基準のリッチ空燃比Ｘに対しよりリッチ側となるモアリッチ空燃比に維持される時間Ｂとを考慮した場合、ＮＯｘ触媒１２のＳ被毒量が多ければ多い程、前記時間Ａに対して前記時間Ｂを短くするか、或いは上述の時間Ａ，Ｂに代えて、排気空燃比が前記リーン側の空燃比に移行するリーン化頻度と、前記モアリッチ空燃比に移行するリッチ化頻度とでみた場合、Ｓ被毒量が多ければ多い程、前記リーン化頻度に対して前記リッチ化頻度は小さくされる。この結果、モアリッチ空燃比での運転頻度が少なくなり、一時的に多量のＳ化合物が生成されるのを効果的に防止できる。

【００２９】更に、上述の排気空燃比の変動制御はＮＯｘ触媒の再生期間（図３参照）の全域に亘って実施しなくとも、ＮＯｘ触媒１２からＳＯｘが所定のレベル以上放出還元される領域のみに実施し、その後は、排気空燃比を理論空燃比または理論空燃比近傍の所定のリッチ空燃比に維持するようにしてもよい。上述した排気空燃比のフィードバック制御にあたり、排気空燃比はそのフィードバック制御の積分ゲイン、または、その比例ゲインを変更することで、リーン空燃比又はモアリッチ空燃比に切換えることができる。具体的には排気空燃比をモアリッチ空燃比に切換えには排気空燃比のためのリッチ化ゲイン（積分又は比例ゲイン）を大、またはリーン化ゲインを小とする制御の少なくとも一方が実施される。

【００３０】また、積分または比例ゲインに代えて、そのフィードバック制御の補正係数の上限値または下限値を変更することで、排気空燃比をリーン側の空燃比またはモアリッチ空燃比に切り換えることもできる。この場合、具体的には、排気空燃比をモアリッチ空燃比に切り換えるには、その補正係数の上限値を大、または小とする制御の少なくとも一方が実施される。

【００３１】更に、上述の実施例ではＮＯｘ触媒１２を昇温させるために、フューエルインジェクタ２の２段噴射を実施するようにしたが、このような２段噴射に代えて、点火時期をリタードさせたり、ＮＯｘ触媒１２を電気ヒータ等の熱源により昇温させるようにしてもよい。

【００３２】

【発明の効果】以上説明したように本発明の内燃機関の排気浄化装置によれば、ＮＯｘ触媒のＳ被毒が許容レベルを超えたときには、その排気空燃比を基準のリッチ空燃比を中心として上下に変動させるようにしたから、排ガスに異臭を発生させることなくＮＯｘ触媒の再生を迅速に行え、燃費の向上とともに、そのコストの低減を図ることができる。

【図面の簡単な説明】

【図１】一実施例の排気浄化装置を備えた内燃機関の概略構成図である。

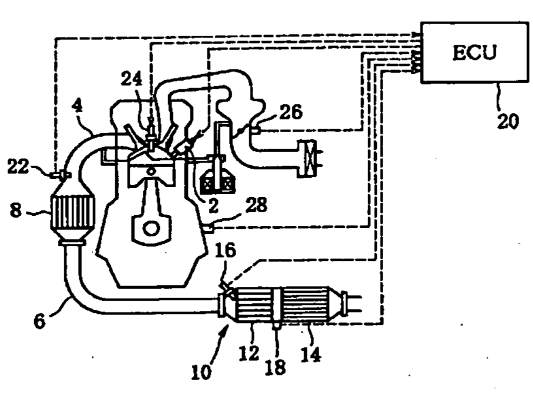
【図２】図１のＥＣＵが実行するＮＯｘ触媒の再生制御ルーチンを示したフローチャートである。

【図３】再生制御の実行中、排気空燃比の変動、排気管内でのＳ化合物の濃度変化、そして車両後方でのＳ化合物の濃度変化を示したタイムチャートである。

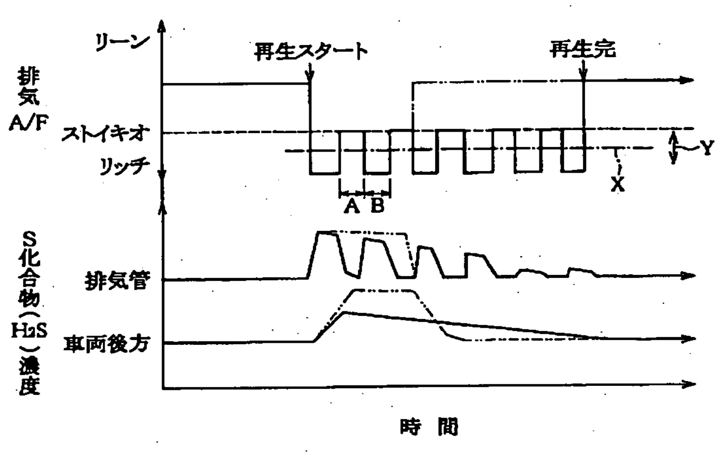
【符号の説明】

２	フューエルインジェクタ
１０	触媒コンバータ
１２	ＮＯｘ触媒
１４	三元触媒
２２	O_2センサ
２０	ＥＣＵ

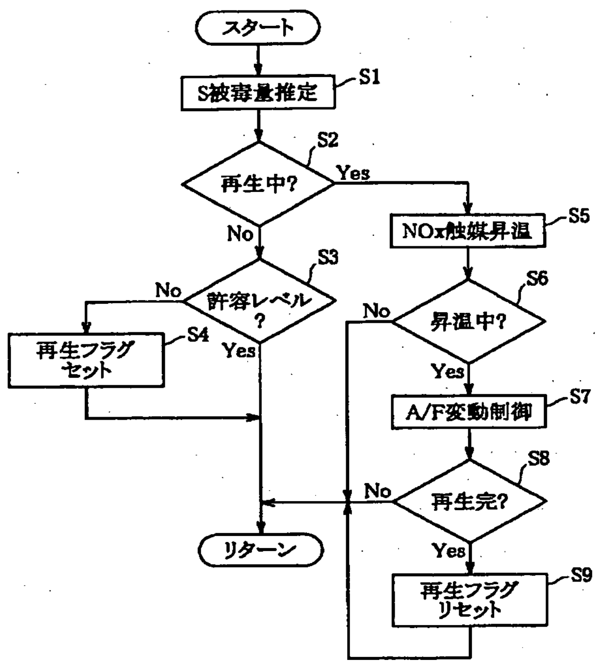
【図１】



【図３】



【図２】



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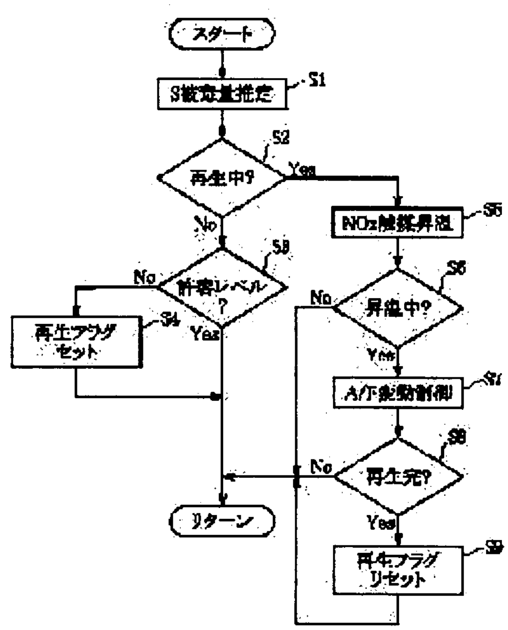
(54) EXHAUST EMISSION CONTROL DEVICE FOR INTERNAL COMBUSTION ENGINE

(57)Abstract:

PROBLEM TO BE SOLVED: To restrict generation of off-flavor due to the sulfur (S) compound included in exhaust gas by fluctuating the exhaust air-fuel ratio of an internal combustion engine around the rich air-fuel ratio as a reference, when sulfur poisoning of the NOx catalyst is detected by a S-poisoning detecting means.

SOLUTION: When storage quantity of NOx of the NOx catalyst, namely, the quantity of S-poisoning is detected (S1), a discrimination as to whether or not the NOx catalyst is being regenerated is done (S2), and if it is 'YES', a fuel injector performs two-stage injection of the fuel so as to raise the temperature of the exhaust gas, namely, the temperature of the NOx catalyst (S5). Thereafter, a discrimination whether or not temperature rise of the NOx catalyst is concluded or not, namely, temperature of the NOx catalyst achieves the SOx activating temperature is done, and if it is 'YES', fluctuation control of the exhaust air-fuel ratio is carried out (S7). The fluctuation control is performed by alternately switching the exhaust air-fuel ratio between the theoretical air- fuel ratio as a lean side of the reference air-fuel ratio and the predetermined rich air-fuel ratio as a richer air-fuel ratio. At the time of switching the air-fuel ratio, detecting signal of an O2 sensor is used.



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CLAIMS

[Claim(s)]
[Claim 1] The exhaust emission control device of an internal combustion engine characterized by providing the following. The NOx catalyst which emits the nitrogen oxide which carried out occlusion when an exhaust air air-fuel ratio was below theoretical air fuel ratio, while it was prepared in the flueway of an internal combustion engine, and carrying out occlusion of the nitrogen oxide in exhaust gas, when an exhaust air air-fuel ratio was a RIN air-fuel ratio, and returns An S poisoning detection means to detect S poisoning of the aforementioned NOx catalyst by the sulfur component in the aforementioned exhaust gas The air-fuel ratio change means from which the sulfur component by which the aforementioned exhaust air air-fuel ratio is fluctuated as a center, and occlusion is carried out [air-fuel ratio] to the aforementioned NOx catalyst in the rich air-fuel ratio of criteria when S poisoning of the aforementioned NOx catalyst is detected with the aforementioned S poisoning detection means is desorbed

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[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] Especially this invention relates to the exhaust emission control device of the internal combustion engine which carried out suitable to no odor-ization of exhaust gas.
[0002]
[Related background technology] In recent years, many thin (RIN) combustion type internal combustion engines are being adopted as vehicles for the purpose of improvement in mpg. Since a lot of nitrogen oxide (NOx) is contained in exhaust gas if it is in this kind of internal combustion engine, the so-called NOx catalyst is arranged to the flueway. This NOx catalyst has the function which emits the NOx which carried out occlusion and is returned, when an internal combustion engine is operated with the rich air-fuel ratio below theoretical air fuel ratio in an exhaust air air-fuel ratio, while carrying out occlusion of the NOx in the exhaust gas, when there is an internal combustion engine on stream with a RIN air-fuel ratio.
[0003] By the way, this kind of NOx catalyst carries out occlusion not only of NOx in exhaust gas but the sulfur component, and causes the fall of the decontamination-capacity force of NOx. That is, a NOx catalyst has the property in which poisoning is carried out by the sulfur component. Discharge reduction of the sulfur component is rapidly carried out from a NOx catalyst by carrying out the temperature up of the NOx catalyst more than predetermined temperature, if S poisoning of a NOx catalyst exceeds a permissible level to JP,6-66129,A in order to cancel such S poisoning for example, and making the circumference into reducing atmosphere that is, and making an exhaust air air-fuel ratio into a rich air-fuel ratio, and the technology of aiming at the reproduction is indicated.
[0004] However, if it is in the exhaust emission control device of JP,6-66129,A mentioned above, the sulfur component desorbed from the NOx catalyst reacts with the hydrocarbon in exhaust gas (HC), and a sulfur (S) compound (hydrogen sulfide : H_2S) generates so much temporarily. If such an S compound, i.e., a hydrogen sulfide, is emitted so much into the atmosphere, it becomes the cause of a nasty smell and is not desirable.
[0005] In order to suppress discharge of the hydrogen sulfide to the inside of the atmosphere from such a situation to JP,8-294618,A, a catalytic converter with the trap and its oxidization function of a hydrogen sulfide is arranged on the lower stream of a river of a NOx catalyst, and, on the other hand, change, i.e., the technology which carries out a perturbation, is indicated between the RIN air-fuel ratio and the rich air-fuel ratio focusing on theoretical air fuel ratio in the exhaust air air-fuel ratio on it.
[0006]
[Problem(s) to be Solved by the Invention] However, although it is indispensable when getting it blocked and supplying oxygen to a catalytic converter in order that the perturbation of an above-mentioned air-fuel ratio may oxidize the hydrogen sulfide which carried out the trap with the catalytic converter in the case of the exhaust emission control device of JP,8-294618,A, such an air-fuel ratio perturbation will cause the further occlusion of the sulfur component to a NOx catalyst, when an exhaust air air-fuel ratio is in a RIN air-fuel ratio, and this will lengthen time which reproduction of a NOx catalyst takes.
[0007] Moreover, if the reproduction time of a NOx catalyst becomes long, increase of the period when an exhaust air air-fuel ratio turns into a rich air-fuel ratio in an air-fuel ratio perturbation will be caused, and mpg will be worsened. Furthermore, since an above-mentioned catalytic converter is special, an exhaust emission control device will also become cost quantity. the nasty smell from which the place which this invention was made based on the above-mentioned situation, and is made into the purpose results S compound in exhaust gas -- suppressing -- in addition -- and it is in offering the exhaust emission control device of the internal combustion engine which does not cause aggravation or the cost quantity of mpg

[0008]
[Means for Solving the Problem] The above-mentioned purpose was attained by the exhaust emission control device of the internal combustion engine in this invention, and this exhaust emission control device is equipped with an S poisoning detection means to detect S poisoning of the NOx catalyst by the sulfur component in exhaust gas, and an air-fuel ratio change means by which the exhaust air air-fuel ratio of an internal combustion engine fluctuates the rich air-fuel ratio of criteria as a center when S poisoning of a NOx catalyst is detected with this S poisoning detection means.
[0009] According to the above-mentioned exhaust emission control device, if an exhaust air air-fuel ratio is changed considering the rich air-fuel ratio of criteria as a center at the time of desorption of the sulfur component from a NOx catalyst That is, rather than the rich air-fuel ratio of criteria, if an exhaust air air-fuel ratio is changed between the MOARITCHI air-fuel ratios by the side of rich rather than the air-fuel ratio by the side of RIN, and the rich air-fuel ratio of criteria From a NOx catalyst, the sulfur component ****s gradually and is not generated temporarily [S compound] and so much in exhaust gas.
[0010] As for the change field of an exhaust air air-fuel ratio, it is desirable to be set below to theoretical air fuel ratio, and, as for a poisoning detection means, it is desirable that it is what detects or presumes the level of S poisoning of a NOx catalyst. And if it is when S poisoning level of a NOx catalyst is detected with S poisoning detection means [whether the more the S poisoning level is high, the more, the rich air-fuel ratio used as the criteria of an air-fuel ratio change means is set as a big value, and] Or [whether time of the aforementioned MOARITCHI air-fuel ratio is shortened from the start of change control of an exhaust air air-fuel ratio by continuing in a predetermined period to the time of the air-fuel ratio by the side of aforementioned RIN in 1 cycle, and] Furthermore, it is desirable to make small the shift frequency to the aforementioned MOARITCHI air-fuel ratio to the shift frequency to the air-fuel ratio by the side of aforementioned RIN.
[0011]
[Embodiments of the Invention] The internal combustion engine roughly shown in drawing 1 is a cylinder-injection-of-fuel type in-series 4-cylinder gasoline engine. This kind of internal combustion engine equips a combustion chamber with the fuel injector 2 which can be injected for fuel directly, and injection of fuel is possible for it at various fuel-injection modes and exhaust air air-fuel ratios according to the operation situation. The intake-stroke injection mode in which inject fuel mainly in an intake stroke in fuel-injection mode, and uniform combustion is specifically performed, If fuel is injected to a compression stroke, and there is compression stroke injection mode in which stratified combustion is performed, especially it is in compression stroke injection mode, combustion with a super-RIN air-fuel ratio (25 or more air-fuel ratios) is possible to the air-fuel ratio (about 12 to 23 air-fuel ratio) in intake-stroke injection mode.
[0012] From the exhaust manifold 4 of an internal combustion engine, an exhaust pipe 6 is prolonged and the small three way component catalyst 8 is inserted in this exhaust pipe 6 at the upper edge. Moreover, the catalytic converter 10 is inserted in the downstream of an exhaust pipe 6. A catalytic converter 10 is the combined thing of the occlusion type NOx catalyst 12 and a three way component catalyst 14, and the NOx catalyst 12 is positioned by the upstream of a three way component catalyst 14. When it is an oxidizing atmosphere (an exhaust air air-fuel ratio is a RIN air-fuel ratio), while a NOx catalyst carries out occlusion of the NOx, when it is in reducing atmosphere (an exhaust air air-fuel ratio is a rich air-fuel ratio), it has the function to return the NOx which carried out occlusion to nitrogen (N2) etc. More specifically, the NOx catalyst 12 has the occlusion material which serves as catalysts, such as platinum (Pt) and a rhodium (Rh), from alkali metal and alkaline earth metal, such as barium (Ba). As mentioned above, the NOx catalyst 12 has the property which carries out occlusion also not only of NOx in exhaust gas but a sulfur component, i.e., SOx, and is high. [of the stability of SOx within the occlusion material of the NOx catalyst 12] so, the NOx catalyst 12 to SOx -- discharge reduction -- carrying out -- the NOx catalyst 12 -- more than a predetermined SOx activation temperature (for example, 650 degrees C) -- a temperature up -- carrying out -- in addition -- and it is necessary to make the circumference into reducing atmosphere
[0013] So, the temperature sensor 16 which detects the temperature of the exhaust gas which flows into the NOx catalyst 12 to a catalytic converter 10, and the concentration sensor 18 which detects the NOx concentration in exhaust gas if needed are formed between the NOx catalyst 12 and the three way component catalyst 14, and these sensors 16 and 18 are connected to the electronic control unit (ECU) 20. Moreover, in addition to the above-mentioned fuel injector 2, O2 sensor 22 which detects the oxygen density in exhaust gas, the ignition plug 24, the throttle opening sensor 26, and the crank angle sensor 28 are also electrically connected to ECU20.
[0014] ECU20 consists of a one board type microcomputer containing a microprocessor, and while change control in the fuel-injection mode mentioned above, and a fuel injector 2 and ignition coil 24 grade carry out drive control based on the detecting signal from an above-mentioned sensor, it carries out SOx reproduction control of a catalytic converter 10. The procedure of the SOx reproduction control is shown in drawing 2 , and this reproduction control is explained

below, referring to drawing 2 .

[0015] First, ECU20 presumes (Step S1)., the amount of SOx occlusion of S poisoning, i.e., amount, of the NOx 12 Specifically, the amount Qs of S poisoning is computed by performing the following formula for every execution period of the fuel-injection control routine which ECU20 performs. Qs(n) =Qs(n-1)+deltaQf-K-Rs -- here, Qs (n) shows a calculation value and Qs (n-1) shows a calculation value last time this time And the integrated value of the injection fuel per execution period, the burst size of SOx, and K of delta Qf and Rs are correction factors.

[0016] A correction factor K is expressed with the product of the correction factor K1 according to the exhaust air air-fuel ratio (A/F), the correction factor K2 according to the content of the sulfur component in fuel, and the correction factor K3 according to the degree of catalyst temperature of the NOx catalyst 12, K1 [i.e.,], K2, and K2. Although the degree of catalyst temperature is called for based on the detecting signal from the temperature sensor 16 mentioned above, the detecting signal from a temperature sensor 16 does not show the temperature of the NOx catalyst 12 directly. so, the map on which the detecting signal of a temperature sensor 16 was set to ECU20 from the target mean effective pressure and engine rotational speed of an internal combustion engine -- being based -- an amendment -- it is things and is made to presume the temperature of the NOx catalyst 12 In addition, it can ask for target mean effective pressure and an engine rotational frequency based on the detecting signal from a throttle opening sensor and a crank angle sensor.

[0017] Moreover, the burst size Rs of SOx is computed from the following formula.

Rs=alpha-R 1, R2, and dT -- here, alpha shows the rate of discharge of SOx per unit time (set point), and dT shows the execution period of a fuel-injection control routine, and R1 and R2 show the discharge capacity coefficient of SOx according to the degree of catalyst temperature, and the discharge capacity coefficient of SOx according to the exhaust air air-fuel ratio

[0018] At Step S1, the amount of S poisoning of the NOx catalyst 12 will distinguish whether presumption, i.e., whether the NOx catalyst 12 is reproducing ECU20 (under S purge) and the reproduction flag mentioned later, is set, if detected (Step S2). Here, still, since the reproduction flag is not set, the distinction result serves as a false (No), and ECU20 distinguishes and carries out whether the amount of S poisoning of the NOx catalyst 12 is below a permissible level (Step S3). When a distinction result here is truth (Yes), ECU20 repeats and carries out Steps S1 and S2. Here, the permissible level of the amount of S poisoning is the set point calculated from the capacity of the NOx catalyst 21.

[0019] On the other hand, if the distinction result of Step S3 becomes a false, ECU20 will set a reproduction flag (step S4). Then, the distinction result of Step S2 serves as truth, and ECU20 carries out the temperature up of the NOx catalyst 12 (Step S5). At this step S5, ECU20 makes two-step injection of fuel perform to a fuel injector 2, and raises the temperature of exhaust gas. In more detail, a fuel injector 2 is that in addition to the main injection of the fuel in the inside of a compression stroke or an intake stroke perform subinjection of fuel in an expansion stroke, and the fuel of this subinjection burns within an exhaust pipe 6, and carries out the temperature up of the temperature of exhaust gas, i.e., the temperature of the NOx catalyst 12. Here, when it is adjusted according to the present degree of catalyst temperature of the NOx catalyst 12 and above-mentioned two-step injection is performed, even if there is subinjection quantity of fuel, it cannot be overemphasized by that the exhaust air air-fuel ratio of the whole is controlled according to the operation situation. In addition, if an internal combustion engine is in a high-speed region and it is in the situation that it has already reached more than the SOx activation temperature which the temperature of the NOx catalyst 12 mentioned above, the subinjection quantity of fuel serves as zero, and two-step injection of fuel will be substantially performed in this case.

[0020] Then, if it results in Step S6, it will be got [whether the temperature up of the NOx catalyst 12 was completed and] blocked, and it will be distinguished whether it is the no which the temperature of the NOx catalyst 12 reached more than the SOx activation temperature. When distinction here is a false, Step S5 is performed repeatedly. When the distinction result of Step S6 becomes truly, ECU20 performs change control (Step S7) of an exhaust air air-fuel ratio (A/F), and the detail is as follows.

[0021] At Step S7, period change of predetermined is carried out for an exhaust air air-fuel ratio up and down a center [the criteria air-fuel ratio X by the side of rich (for example, 14.35)]. Specifically, an exhaust air air-fuel ratio is switched to every predetermined time (for example, 5 seconds) by turns from the criteria air-fuel ratio X between the theoretical air fuel ratio (14.7) as an air-fuel ratio by the side of RIN, and the predetermined rich air-fuel ratio (for example, 14.0) as a MOARITCHI air-fuel ratio. In addition, to say nothing of the detecting signal from O2 sensor 22 mentioned above being used for the change of an exhaust air air-fuel ratio, it is the average by which an exhaust air air-fuel ratio is obtained from the detecting signal of O2 sensor in this case.

[0022] If change control (S purge) of an exhaust air air-fuel ratio is performed as it mentioned above, as shown in drawing 3 , an exhaust air air-fuel ratio will be changed to the upper and lower sides focusing on the rich air-fuel ratio X of criteria in the field by the side of rich rather than theoretical air fuel ratio (strike IKIO). So, since discharge reduction

of the SOx by which occlusion was carried out to the NOx catalyst 12 is carried out by the time of changing the exhaust air air-fuel ratio to a rich side more at a large quantity, within an exhaust pipe 6, it fluctuates periodically and the concentration of S compound can decrease the concentration average per the time. Moreover, it is related with periodic discharge of S compound so that clearly from drawing 3 , and the concentration level of S compound at the time of the discharge decreases gradually with the passage of time, and this is based on the amount of occlusion of SOx within the NOx catalyst 12 decreasing gradually.

[0023] Therefore, even if above-mentioned change control, i.e., reproduction control of the NOx catalyst 12, is performed, it is not emitted temporarily [S compound] and so much in an exhaust pipe 6. This can suppress effectively the nasty smell which means not being generated temporarily [the hydrogen sulfide (H_2S) obtained according to the chemical reaction of S compound and the reducing agent of H_2 grade within an exhaust pipe 6], and so much, consequently originates in a hydrogen sulfide.

[0024] In drawing 3 , concentration change of S compound in a vehicles back region is also shown, and the two-dot chain line in drawing 3 shows concentration change of S compound in the exhaust air within the pipe one and the vehicles back region in the case where it is continued more by maintaining an exhaust air air-fuel ratio the air-fuel ratio by the side of rich, respectively. About concentration change of S compound, if the solid line and two-dot chain line in drawing 3 are compared, in the case of this example, a lot of hydrogen sulfides will not be discharged to vehicles back immediately after the start of the change control, and crew a self-vehicle or consecutiveness in the car will not receive the sense of incongruity by the nasty smell so that clearly.

[0025] During reproduction of the NOx catalyst 12 mentioned above, since an exhaust air air-fuel ratio is not switched to an adult RIN air-fuel ratio rather than theoretical air fuel ratio, the NOx catalyst 12 can be reproduced quickly and improvement in mpg is achieved. And in the case of this example, the special catalyst for carrying out the trap of the hydrogen sulfide is not needed, but a cheap exhaust emission control device can be offered. After execution of Step S7, ECU20 repeats and performs Step S7 until it distinguishes whether reproduction of the above-mentioned NOx catalyst 12 was completed (Step S8) and a distinction result here serves as truth. On the other hand, if the distinction result of Step S8 becomes truly, ECU20 will reset a reproduction flag (step S9), and distinction of Step S3 will be performed after this repeatedly. Here, distinction at Step S8 can be carried out based on the elapsed time after change control (Step S7) of an exhaust air air-fuel ratio is started, or the amount of S occlusion presumed at Step S1.

[0026] In case ECU20 fluctuates the exhaust air air-fuel ratio rather than the rich side air-fuel ratio of criteria between the air-fuel ratio by the side of RIN (theoretical air fuel ratio), and the air-fuel ratio by the side of rich, it can use feedback control or open loop control. In addition, with this operation gestalt, although it is made to change between theoretical air fuel ratio and a MOARITCHI air-fuel ratio to the criteria air-fuel ratio X, you may set the air-fuel ratio by the side of RIN to the criteria air-fuel ratio X as the air-fuel ratio by the side of rich a little rather than theoretical air fuel ratio.

[0027] Moreover, the reproduction routine of the NOx catalyst 12 in drawing 3 may be performed for every predetermined period in consideration of rolling-stock-run distance etc. In this case, if it hits performing change control (Step S7) of an exhaust air air-fuel ratio, as the drawing 3 Nakaya mark Y shows the range of fluctuation of the air-fuel ratio based on the amount of S poisoning of the NOx catalyst 12 at the fixed time, you may be made to carry out adjustable [of the level of the rich air-fuel ratio X of the criteria] up and down. Specifically, the more there are many amounts of S poisoning, the more the variation rate of the rich air-fuel ratio X of criteria is carried out more to a theoretical-air-fuel-ratio side. Thus, if the variation rate of the rich air-fuel ratio X of criteria is carried out, as a result of suppressing the deflection of the exhaust air air-fuel ratio by the side of rich, prevention can perform effectively that S compound will be generated temporarily in an exhaust pipe 6, and so much. In addition, as for the air-fuel ratio by the side of RIN, a bird clapper is permitted by theoretical air fuel ratio a RIN side from the rich air-fuel ratio of criteria.

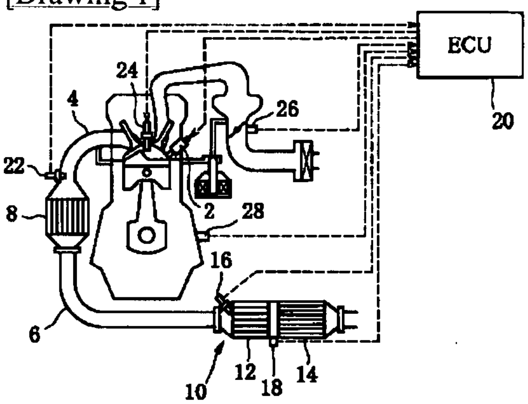
[0028] It is based on the same meaning. moreover, when the rich air-fuel ratio X of criteria is fixed The time A maintained by the air-fuel ratio which an exhaust air air-fuel ratio turns into a RIN side to the rich air-fuel ratio X of criteria as shown in drawing 3 among 1 change cycle of an air-fuel ratio When the time B maintained by the MOARITCHI air-fuel ratio which becomes a rich side more to the rich air-fuel ratio X of criteria is taken into consideration, The RIN-ized frequency by which the aforementioned time B is shortened to the aforementioned time A, or it replaces with at the above-mentioned time A and B, and an exhaust air air-fuel ratio shifts to the air-fuel ratio by the side of aforementioned RIN the more the more there are many amounts of S poisoning of the NOx catalyst 12, When it sees by the rich-ized frequency which shifts to the aforementioned MOARITCHI air-fuel ratio, the more there are many amounts of S poisoning, the more the aforementioned rich-ized frequency is made small to the aforementioned RIN-ized frequency. Consequently, the operation frequency in a MOARITCHI air-fuel ratio decreases, and it can prevent effectively that a lot of S compounds are generated temporarily.

[0029] Furthermore, change control of an above-mentioned exhaust air air-fuel ratio is carried out only to the field to which discharge reduction of the SOx is carried out more than predetermined level from the NOx catalyst 12 even if it continues throughout the reproduction period (refer to drawing 3) of a NOx catalyst and does not carry out, and you may make it maintain an exhaust air air-fuel ratio after that to theoretical air fuel ratio or the predetermined rich air-fuel ratio near the theoretical air fuel ratio. An exhaust air air-fuel ratio can be switched to a RIN air-fuel ratio or a MOARITCHI air-fuel ratio in the feedback control of the exhaust air air-fuel ratio mentioned above by changing the integration gain of the feedback control, or its proportional gain. Specifically, at least one side of the control which makes size or RIN-ized gain smallness for the rich-ized gain for an exhaust air air-fuel ratio (integration or proportional gain) at a change is carried out by the MOARITCHI air-fuel ratio in an exhaust air air-fuel ratio.
[0030] Moreover, an exhaust air air-fuel ratio can also be switched to the air-fuel ratio or MOARITCHI air-fuel ratio by the side of RIN by replacing with integration or proportional gain and changing the upper limit or lower limit of a correction factor of the feedback control. In this case, specifically, in order to switch an exhaust air air-fuel ratio to a MOARITCHI air-fuel ratio, at least one side of the control which makes the upper limit of the correction factor size or smallness is carried out.
[0031] Furthermore, although it was made to carry out two-step injection of a fuel injector 2 in the above-mentioned example in order to carry out the temperature up of the NOx catalyst 12, it replaces with such two-step injection, and you may carry out the retard of the ignition timing, or may be made to carry out the temperature up of the NOx catalyst 12 with heat sources, such as an electric heater.
[0032]
[Effect of the Invention] Since it was made for the exhaust air air-fuel ratio to fluctuate the rich air-fuel ratio of criteria up and down as a center when S poisoning of a NOx catalyst exceeded a permissible level according to the exhaust emission control device of the internal combustion engine of this invention, as explained above, a NOx catalyst can be reproduced quickly, without making exhaust gas generate a nasty smell, and reduction of the cost can be aimed at with improvement in mpg.

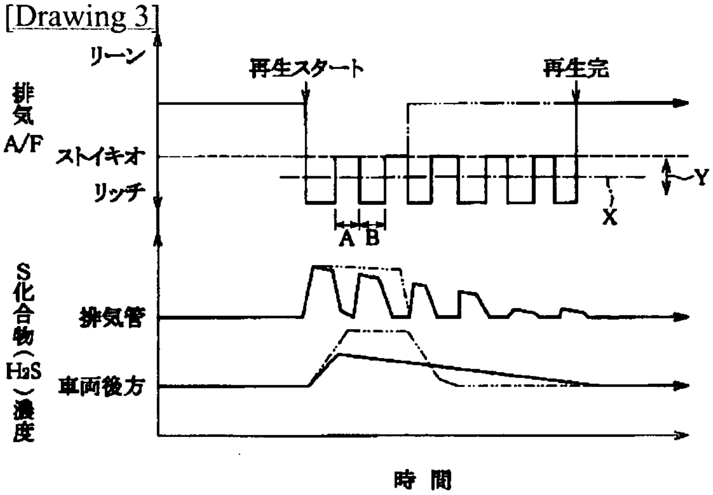
[Translation done.]

DRAWINGS

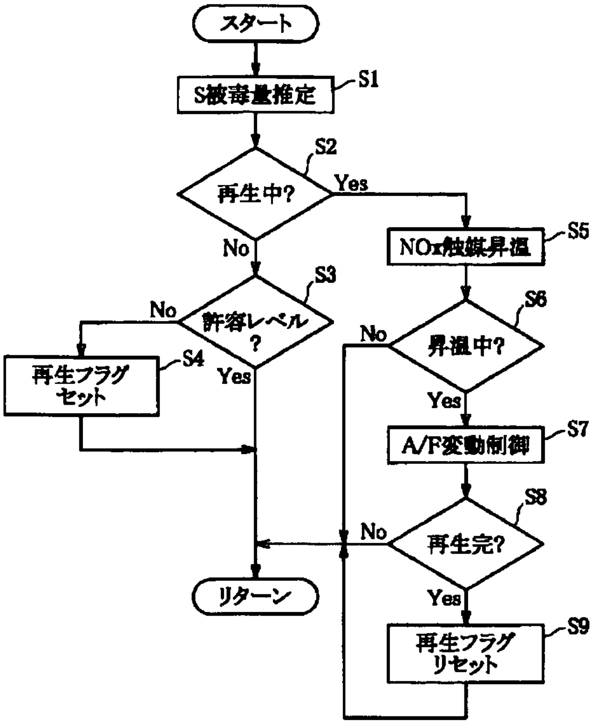
[Drawing 1]



[Drawing 3]



[Drawing 2]



[Translation done.]